

# Canine DLA diversity: 1. New alleles and haplotypes

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## Abstract

The aim of this component was to establish the range of DLA diversity in as many dog breeds as possible. In particular, we wanted to collect breeds that had not previously been studied. Data were submitted of 937 dogs of over 80 different breeds, and these included 17 'new' breeds. Twenty-eight new alleles were identified including 21 DLA-DRB1, 2 DLA-DQA1 and 5 DLA-DQB1 alleles. These occurred in many new haplotype combinations. One haplotype was identified that appeared to lack DQB1. Two other haplotypes carry two DQB1 genes. It was clear that each dog breed has a restricted range of DLA alleles and haplotypes, and no breed had all 88 haplotypes identified in this study.

There were several aims for this component:

- to study DLA alleles and haplotypes in previously unsampled breeds,
- to identify new DLA alleles and haplotypes and
- to compare dogs of the same breed from different geographical locations.

In this part of the DLA workshop, 937 dogs of over 80 different breeds were submitted. These included dogs from 17 breeds that had not previously been characterised for DLA class II polymorphisms: Alaskan Malamute, Australian Cattle Dog (Blue Heeler), Dachshund, Tibetan Terrier, husky, Brazilian mongrel, Tanzanian mongrel, Ibizan Hound, German Langhaar, Croatian Pudl (miniature and medium), Croatian Sheepdog, Tornjak (Croatian Mountain dog) and four Russian breeds, Middle Asian Shepherd Dog, Caucasian Shepherd Dog, Caucasian Volfdog and West Siberian Laika. Unfortunately, it was not possible to collect large cohorts of the same breed from different geographical locations.

Many new DLA alleles were identified in this study: 21 DLA-DRB1, 2 DLA-DQA1 and 5 DLA-DQB1 alleles

(Tables 1, 2 and 3, respectively). All these alleles were found in many different animals, both homozygous and heterozygous. Some had been found in previous studies (L. J. Kennedy, unpublished results) and confirmed in this study. Alleles only found in heterozygous animals have been DNA cloned and sequenced. One way of confirming the identification of a new allele is to show that it is found in combination with the same alleles at the other two loci, e.g. the allele DLA-DRB1\*07801 was found on a haplotype with DLA-DQA1\*00401 and DLA-DQB1\*01303 in three different husky dogs. These dogs were also part of a family, and the haplotype could be seen to be inherited from parent to offspring (1). Each of the new alleles listed in Tables 1–3 was found on a distinctive haplotype, which are listed in the tables. One allele, DLA-DRB1\*08001, appears to have no DQB1 allele on its haplotype, just DQA1\*00402. The haplotype occurs at a relatively high frequency [eight dogs out of 42 (19.0%)] in Middle Asian Shepherd Dogs, but despite this frequency, no dogs homozygous for this haplotype were observed. There are several possible explanations for this lack of a DQB1 allele. The haplotype may lack the DQB1

**Table 1** New DRB1 alleles and haplotypes

DRB1*	Breeds found in	DRB1	DQA1	DQB1	Accession No.	Contributing laboratory
00203	Dachshund	00203	00901	00101	AM076472	MAN
06801	Setter (Irish)	06801	00101	00201	AM076470	MAN
06901	Ibizan Hound	06901	00101	00201	AM076471	UAB
07001	Husky	07001	01801	05001	AM076474	AKA
07101	Rhodesian Ridgeback	07101	00901	00101	AM076475	MAN
07201	Labrador	07201	00401	01303	AM076476	MAN
07301	Dachshund, Afghan	07301	00201	01303	AM076477	MAN
07401	Brazilian mongrel, Maltese Terrier	07401	005011	00701	AM076478	MAN
07501	Terrier (Yorkshire)	07501	00201	01303	AM076479	MAN
02302	Brazilian mongrel	02302	00301	00501	AM076473	MAN
07601	Poodle cross	07601	00601	02301	AM076480	MAN
033012	Shih Tzu	033012	00301	03801	AM076483	MAN
07701	Shih Tzu	07701	00601	02301	AM076481	MAN
07801	Husky	07801	00401	01303	AM076482	AKA
00103	Beagle cross	00103	00101	00201	AM084382	MAN
07901	Tibetan Terrier	07901	00101	00201	AM182460	MAN
08001	Middle Asian Shepherd Dog	08001	00402	None	AM182461	NOV
08101	Tanzanian mongrel	08101	00101	00802	AM182462	MAN
08201	Alaskan Malamute	08201	00601	05401	DQ528654	UQU
08301	Pharaoh Hound	08301	00201	01303	AM182463	MAN
08401	Croatian Pudl (medium)	08401	00901	00101	AM182464	CRO

gene, or it may be that the primers do not amplify the allele that is present. This can be checked by designing exonic primers, and sequencing the resulting PCR fragments.

There are two other haplotypes of interest to report. Each of them appears to carry two DQB1 alleles, as detected in sequence based typing (SBT). These are DLA-DRB\*01201/DQA1\*00401/DQB1\*01303/DQB1\*01701 and DLA-DRB\*01501/DQA1\*00601/DQB1\*01901/DQB1\*02201. DNA from a dog carrying the DRB1\*01201 haplotype has been cloned and sequenced, revealing both alleles to be present. The inheritance of this haplotype has been followed in several multi-generation families (L. J. Kennedy, unpublished results), both by SBT and reference strand-mediated conformation analysis (RSCA) (2). Two DQB1 alleles have also been shown to be present in one haplotype by the gene-matching technique (3). The presence of some characteristic triplet nucleotide peaks in the sequencing traces suggests the presence of three DQB1 alleles in animals that are heterozygous for one of these duplicated DQB1 haplotypes. Many of these dogs have also been tested by RSCA and the results clearly show three allele peaks. The DRB1\*01201 haplotype is particu-

larly common in Labradors, Newfoundlands and Golden Retrievers, but is found less frequently in at least nine other breeds. Interestingly, a DRB1\*01201 haplotype carrying only DQB1\*01303 also occurs, mostly in Golden Retrievers. The DRB1\*01501 haplotype with a duplicated DQB1 gene has almost exclusively been found in Samoyeds to date, although in this workshop, one husky and three West Siberian Laikas were also found to carry it. Interestingly, while to date, no haplotypes have been found that carry DQB1\*01701 alone, several haplotypes exist that carry the DQB1\*01303, 01901 and 02201 alleles alone. Thus, it is hard to postulate that one allele of each pair on these haplotypes with duplicated DQB1 genes belongs to another separate locus. There is some evidence of a third such haplotype, which carries DQB1\*01303 and DQB1\*02301. It is unknown whether these are full or partial gene duplications.

The alleles reported here bring the official number of DLA alleles to 100 DLA-DRB1, 26 DLA-DQA1 and 60 DLA-DQB1. Table 4 lists the alleles that are most like the new alleles found in the workshop. Interestingly, new alleles fall into two main groups, those that are unlike any allele

**Table 2** New DQA1 alleles and haplotypes

DQA1*	Breeds found in	DRB1	DQA1	DQB1	Accession No.	Contributing laboratory
01801	Husky	07001	01801	05001	AM182471	AKA
02101	Terrier (Maltese)	01501	02101	05301	DQ499152	UQU

**Table 3** New DQB1 alleles and haplotypes

DQB1*	Breeds found in	DRB1	DQA1	DQB1	Accession No.	Contributing laboratory
04801	Ibizan Hound	01503	00601	04801	AM182472	UAB
04901	Middle Asian Shepherd Dog	01501	00601	04901	AM182473	NOV
05001	Husky	07001	01801	05001	AM182474	AKA
05301	Terrier (Maltese)	01501	02101	05301	DQ499153	UQU
05401	Alaskan Malamute	08201	00601	05401	DQ528655	UQU

previously found, e.g. DLA-DRB1\*08401, and those that are only a few base pairs different from known alleles, e.g. DLA-DRB1\*06801. Some alleles occur in clusters, all of which are only one or two base pairs different, e.g. the DLA-DRB1\*015 group, which comprises DRB1\*01501, 01502, 01503, 01504, 03001, 03801, 07601 and 08201. The DLA-DRB1\*015 group also tend to be found with the same DLA-DQ combinations, usually DQA1\*00601 with DQB1\*02301, 00301, 02201, 02002 or 02601. Interestingly, these DQB1 alleles also comprise a cluster of alleles that are only one or two base pairs different. Alignments of the DLA alleles can be found as supplementary material on the Immuno Polymorphism Database web site (<http://www.ebi.ac.uk/ipd/mhc/index.html>).

Table 5 lists the numbers of dogs of each breed that were submitted to the workshop; these include all the family and disease samples as well as the samples from normal dogs.

Not surprisingly, every new allele identified occurs on a new haplotype. Table 6 lists the 88 haplotypes identified in more than one dog in this study. Haplotype frequencies are given, but these merely reflect the combination of breeds that were studied in this workshop and are skewed compared with previously published data (4–6) because of the large number of mongrels in this data set. It is clear that not all DRB1 alleles are found on haplotypes with all possible DQ combinations. Each DLA-DRB1 allele has

**Table 4** Similarities of new alleles

Locus	Allele	Allele most similar to
DRB1	00203	1 aa different from DRB1*00201
DRB1	06801	1 aa different from DRB1*00101
DRB1	06901	2 aa different from DRB1*00101
DRB1	07001	Very different
DRB1	07101	Very different
DRB1	07201	4 aa different from DRB1*01201
DRB1	07301	1 aa different from DRB1*0702
DRB1	07401	1 aa different from DRB1*07301
DRB1	07501	1 aa different from DRB1*02001
DRB1	02302	1 aa different from DRB1*02301
DRB1	07601	1 aa different from DRB1*01501
DRB1	033012	One synonymous base pair different from DRB1*033011
DRB1	07701	Very different
DRB1	07801	Very different
DRB1	00103	1 aa different from DRB1*00101
DRB1	07901	5 aa different from DRB1*05301
DRB1	08001	1 aa different from DRB1*02501
DRB1	08101	6 aa different from DRB1*00601
DRB1	08201	1 aa different from DRB1*01501
DRB1	08301	1 aa different from DRB1*07301
DRB1	08401	Very different
DQA1	01801	1 aa different from DQA1*00601
DQA1	02101	1 aa different from DQA1*01101
DQB1	04801	1 aa different from DQB1*00301
DQB1	04901	1 aa different from DQB1*01601
DQB1	05001	3 aa different from DQB1*01901
DQB1	05301	1 aa different from DQB1*02002
DQB1	05401	2 aa different from DQB1*02201

**Table 5** Number of dogs by breed

Breed	<i>n</i>	Breed	<i>n</i>
Afghan Hound	1	Poodle (Miniature)	17
Alaskan Malamute	11	Poodle (Standard)	2
Australian Cattle Dog	11	Poodle (Toy)	5
Australian Shepherd Dog	2	Poodle-Beagle-Elkhound X	93
Basset Hound	5	Pudl (medium)	3
Beagle	67	Pudl (mini)	2
Bernese Mountain Dog	3	Pyrenean Mountain Dog	1
Bichon Frise	22	Retriever (Chesapeake Bay)	1
Bouvier	1	Retriever (Flat-coated)	4
Boxer	41	Retriever (Golden)	31
Bulldog	5	Rhodesian Ridgeback	82
Chow Chow	6	Rottweiler	8
Collie	14	Samoyed	15
Collie (Bearded)	4	Schnauzer (German)	1
Collie (Border)	22	Schnauzer (Miniature)	13
Collie (Rough)	1	Setter (English)	41
Corgi	4	Setter (Gordon)	5
Dachshund	3	Setter (Irish)	3
Dachshund (Long Haired)	3	Sheepdog (Old English)	6
Dachshund (Miniature Short Haired)	11	Sheepdog (Shetland)	4
Dachshund (Miniature)	1	Shepherd Dog (Caucasian)	6
Dachshund (Short Haired)	5	Shepherd Dog (Middle Asian)	42
Dachshund (Wire Haired)	1	Shih Tzu	13
Dalmatian	4	Spaniel (American Cocker)	2
Deerhound	1	Spaniel (Cavalier King Charles)	14
Doberman	183	Spaniel (Clumber)	1
German Langhaar	1	Spaniel (Cocker)	30
German Shepherd Dog Spain	13	Spaniel (Springer)	12
German Shepherd Dog UK	14	Spaniel (Welsh Springer)	1
Great Dane	5	Spitz (German)	1
Hovawart	4	St Bernard	1
Husky (Alaskan)	10	Tanzanian mongrel	27
Husky (Siberian)	1	Terrier (Airedale)	2
Ibizan Hound	51	Terrier (Border)	10
Irish Wolfhound	1	Terrier (Bull)	1
Japanese Akita	1	Terrier (Cairn)	12
Labrador	88	Terrier (Dandie Dinmont)	1
Lagotto Romagnola	1	Terrier (Fox)	1
Laika (West Siberian)	13	Terrier (Jack Russell)	39
Leonburger	1	Terrier (Lakeland)	1
Lhasa Apso	5	Terrier (Maltese)	1
Lurcher	4	Terrier (Norwich)	1
Malamute	1	Terrier (Scottish)	2
Mongrel Brazilian	112	Terrier (Soft Coated Wheaten)	1
Newfoundland	75	Terrier (Staffs Bull)	19
Norwegian Elkhound	1	Terrier (Tibetan)	6
Papillon	3	Terrier (West Highland White)	22
Petit Basset Griffon Vendeen	1	Terrier (Yorkshire)	44
Pharaoh Hound	1	Vizsla Hungarian	2
Pointer	1	Volfdog (Caucasian)	12
Pointer (German Short haired)	1	Weimaraner	2
Polish Lowland Sheepdog	1	Weimaraner	1
Pomeranian	2	X-Crossbreed	87
Poodle	2		

**Table 6** Haplotype frequencies in the workshop population

<i>N</i> = 1562	Haplotype frequency	DRB1	DQA1	DQB1	Number of breeds found in (Total number of breeds = 107)
247	0.079	00101	00101	00201	50 breeds
31	0.010	00101	00101	03601	Jack Russell + 10 other breeds
3	0.001	00101	00201	01303	Springer Spaniel and Jack Russell Terrier
11	0.004	00101	00301	00401	Rottweiler + 2 others
5	0.002	00101	00301	00501	Alaskan Malamute + 2 others
14	0.004	00101	00901	00101	West Highland White Terrier + 2 others
37	0.012	00102	00101	00201	Beagle, German Shepherd + 4 others
16	0.005	00103	00101	00201	English and Irish Setters
116	0.037	00201	00901	00101	Doberman, Newfoundland + 28 others
10	0.003	00202	00901	00101	7 breeds
5	0.002	00203	00901	00101	Dachshund
3	0.001	00301	00101	00802	Poodle
33	0.011	00401	00201	01501	Boxer + 4 others
6	0.002	00501	00301	00501	6 breeds
20	0.006	00601	00101	00802	Beagle
171	0.055	00601	00401	01303	Doberman + 5 others
252	0.081	00601	005011	00701	40 breeds
4	0.001	00601	005011	01303	Doberman + 1 other
46	0.015	00601	005011	02001	Newfoundland, Golden Retriever + 5 others
8	0.003	00601	005011	02801	Airedale Terrier + 3 others
5	0.002	00801	00301	00401	4 breeds
20	0.006	00802	00301	00401	Ibizan Hound + 2 others
4	0.001	00901	00101	00201	4 breeds
92	0.029	00901	00101	008011	Ibizan Hound, Samoyed, Miniature Schnauzer, Jack Russell Terrier + 25 others
9	0.003	00901	00101	00802	Collie, Samoyed + 2 others
4	0.001	00901	00101	04601	Samoyed
20	0.006	010011	00201	01501	Basset Hound, Miniature Poodle
28	0.009	01101	00201	01302	German Shepherd Dog + 9 others
27	0.009	01101	00201	01303	8 breeds
60	0.019	01201	00101	00201	Doberman and Retriever
114	0.036	01201	00401	013017	Labrador, Newfoundland, Golden Retriever + 16 others
17	0.005	01201	00401	01303	Golden Retriever
113	0.036	01301	00101	00201	Rhodesian Ridgeback, Old English Sheepdog + 24 others
8	0.003	01301	00301	00501	4 breeds
53	0.017	01501	00601	00301	German Shepherd Dog + 18 others
6	0.002	01501	00601	01101	West Highland White Terrier + 2 others
17	0.005	01501	00601	019022	Laika, Samoyed
6	0.002	01501	00601	02001	3 breeds
53	0.017	01501	00601	02002	Border Terrier + 15 others
14	0.004	01501	00601	02201	Yorkshire Terrier + 3 others
217	0.069	01501	00601	02301	38 breeds
21	0.007	01501	00601	02601	Brazilian mongrel + 3 others
5	0.002	01501	00601	04901	Middle Asian Shepherd Dog
44	0.014	01501	00901	00101	Doberman, Beagle + 11 others
3	0.001	01501	02101	05301	Maltese Terrier
4	0.001	01502	00601	00301	4 breeds
109	0.035	01502	00601	02301	Labrador + 29 others
3	0.001	01502	00601	02601	3 breeds
3	0.001	01502	00901	00101	2 breeds
3	0.001	01503	00601	00301	Chow Chow + 1 other
5	0.002	01503	00601	02301	Poodle
21	0.007	01503	00601	04801	Ibizan Hounds
4	0.001	01601	00101	00201	3 breeds
4	0.001	01701	00201	01303	3 breeds
4	0.001	01702	00201	01304	Brazilian mongrel

**Table 6** *Continued*

N = 1562	Haplotype frequency	DRB1	DQA1	DQB1	Number of breeds found in (Total number of breeds = 107)
11	0.004	01801	00101	00201	Bearded Collie + 6 others
39	0.012	01801	00101	00802	Rhodesian Ridgeback, Lurcher, Bearded Collie + 8 others
3	0.001	02001	00401	01302	2 breeds
85	0.027	02001	00401	01303	Cavalier King Charles Spaniel, Golden Retriever + 23 others
19	0.006	02301	00301	00501	Border Collie, Yorkshire Terrier + 4 others
11	0.004	02501	012012	03501	Shih Tzu
6	0.002	03001	00601	00301	Newfoundland
4	0.001	03301	00301	03801	Shih Tzu
8	0.003	04001	01001	01901	Husky + 4 others
4	0.001	04601	01501	00802	Papillon, Brazilian mongrel
5	0.002	04801	00101	008011	3 breeds
5	0.002	04801	00101	00802	5 breeds
7	0.002	04801	00402	03101	Middle Asian Shepherd Dog, Volfdog
1	0.000	04901	005011	03901	Brazilian mongrel
2	0.001	05001	00601	02302	Brazilian mongrel
3	0.001	05101	00201	02901	Brazilian mongrel
25	0.008	05201	012011	03501	Brazilian mongrel + 1 other
3	0.001	05301	00301	00502	Shih Tzu, Middle Asian Shepherd Dog
1	0.000	05401	00601	02301	Border Collie
16	0.005	06901	00101	00201	Ibizan Hound
2	0.001	07001	01801	05001	Husky
5	0.002	07301	00201	01303	Dachshund
3	0.001	07401	005011	00701	74 breeds
2	0.001	07501	00401	01303	Yorkshire Terrier
43	0.014	07601	00601	02301	Poodle
2	0.001	07801	00401	01303	Husky
4	0.001	07901	00101	00201	Tibetan Terrier
8	0.003	08001	00402	none	Middle Asian Shepherd Dog
4	0.001	08101	00101	00802	Tanzanian mongrel
4	0.001	08201	00601	05401	Alaskan Malamute
1	0.000	08301	00201	01303	Pharaoh Hound
1	0.000	08401	00601	02301	Poodle
2	0.001	08401	00901	00101	Poodle
144	0.046	Other single haplotypes			

a DQA1/B1 pair with which it is commonly found. Unusual combinations tend to occur only in certain breeds. For example, DRB1\*01501 is most often found with DQA1\*00601/DQB1\*02301; however, in Beagles, DRB1\*01501 is usually found with DQA1\*00901/DQB1\*00101.

Overall, 25% of the dogs are homozygous for all three loci, 33.5% for DRB1, 39.7% for DQA1 and 32.9% for DQB1. These rates are lower than those previously reported (35.1%) (6), and reflect the large numbers of mongrels within the workshop data set.

Table 7 lists the haplotypes found in each of the more frequent breeds in this study. It is clear that no breed has all the 88 haplotypes listed in Table 6. Jack Russell Terriers have the most with 21 different haplotypes. The only groups

with more haplotypes are the various types of mongrels, which represent admixtures of many different breeds.

This component of the DLA workshop clearly demonstrates that there is much more DLA diversity to be discovered, as every time a new breed is sampled, new alleles and haplotypes are identified. As the numbers of dogs per breed and the number of breeds studied increase, it should be possible to use the major histocompatibility complex (MHC) to identify genetic similarities between the breeds and to generate a 'family' tree of which breeds are most closely MHC related. The data generated in the workshop have significantly increased our database of MHC-genotyped dogs, and it should be possible to draw such a relationship tree in the near future.

**Table 7** Three locus DLA haplotypes found in different dog breeds.

Breed	<i>n</i> = 1604	No. of dogs	Dogs of the breed (%)	DRB1	DQA1	DQB1
Afghan Hound	1	1	100.0	01503	00601	New
Alaskan Malamute	11	3	27.3	00101	00301	00501
Alaskan Malamute	11	1	9.1	00601	005011	02001
Alaskan Malamute	11	2	18.2	01101	00201	01303
Alaskan Malamute	11	9	81.8	01501	00601	02301
Alaskan Malamute	11	1	9.1	01503	00601	00301
Alaskan Malamute	11	4	36.4	08201	00601	05401
Australian Cattle Dog	11	7	63.6	00201	00901	00101
Australian Cattle Dog	11	1	9.1	01301	00301	00501
Australian Cattle Dog	11	6	54.5	01501	00601	00301
Australian Cattle Dog	11	5	45.5	01501	00601	02002
Australian Cattle Dog	11	1	9.1	01501	00601	02301
Australian Cattle Dog	11	1	9.1	02901	00301	00401
Australian Shepherd Dog	2	1	50.0	01301	00301	00501
Australian Shepherd Dog	2	2	100.0	01501	00601	02301
Australian Shepherd Dog	2	1	50.0	04001	01001	01901
Basset Hound	5	2	40.0	00601	005011	00701
Basset Hound	5	2	40.0	010011	00201	01501
Basset Hound	5	4	80.0	01501	00601	02301
Beagle	67	8	11.9	00101	00101	00201
Beagle	67	27	40.3	00102	00101	00201
Beagle	67	9	13.4	00201	00901	00101
Beagle	67	3	4.5	00202	00901	00101
Beagle	67	20	29.9	00601	00101	00802
Beagle	67	30	44.8	00601	005011	00701
Beagle	67	2	3.0	00801	00301	00401
Beagle	67	1	1.5	01301	00301	00501
Beagle	67	13	19.4	01501	00901	00101
Bernese Mountain Dog	3	2	66.7	00601	005011	00701
Bernese Mountain Dog	3	1	33.3	01301	00101	00201
Bernese Mountain Dog	3	1	33.3	01501	00601	02002
Bernese Mountain Dog	3	1	33.3	04801	00101	00802
Bichon Frise	22	5	22.7	00601	005011	00701
Bichon Frise	22	1	4.5	00901	00101	00201
Bichon Frise	22	1	4.5	00901	00101	008011
Bichon Frise	22	5	22.7	01301	00101	00201
Bichon Frise	22	17	77.3	01501	00601	02301
Bichon Frise	22	1	4.5	01501	00901	00101
Bichon Frise	22	2	9.1	01502	00901	00101
Bouvier	1	1	100.0	00601	005011	01303
Bouvier	1	1	100.0	02001	00401	01303
Boxer	41	29	70.7	00401	00201	01501
Boxer	41	4	9.8	00601	005011	00701
Boxer	41	2	4.9	01201	00401	01303/01701
Boxer	41	13	31.7	01301	00101	00201
Boxer	41	10	24.4	01502	00601	02301
Bulldog	5	1	20.0	00601	005011	00701
Bulldog	5	3	60.0	01501	00601	02301
Bulldog	5	2	40.0	01502	00601	02301
Bulldog	5	1	20.0	04801	00101	00802
Chow Chow	6	2	33.3	00101	00101	00201
Chow Chow	6	3	50.0	01501	00901	00101
Chow Chow	6	2	33.3	01503	00601	00301
Chow Chow	6	1	16.7	01801	00101	00802
Chow Chow	6	4	66.7	02001	00401	01303
Collie	14	1	7.1	00101	00101	00201

**Table 7** *Continued*

Breed	<i>n</i> = 1604	No. of dogs	Dogs of the breed (%)	DRB1	DQA1	DQB1
Collie	14	1	7.1	00101	00101	03601
Collie	14	1	7.1	00201	00101	00802
Collie	14	6	42.9	00201	00901	00101
Collie	14	1	7.1	00601	00201	01303
Collie	14	1	7.1	00901	00101	00802
Collie	14	1	7.1	01201	00401	01303
Collie	14	1	7.1	01201	00401	01303/01701
Collie	14	2	14.3	01301	00101	00201
Collie	14	3	21.4	01501	00601	02301
Collie	14	2	14.3	01502	00601	02301
Collie	14	1	7.1	01701	00201	01303
Collie	14	2	14.3	01801	00101	00201
Collie (Bearded)	4	1	25.0	00901	00101	00802
Collie (Bearded)	4	1	25.0	01501	00601	00301
Collie (Bearded)	4	2	50.0	01801	00101	00201
Collie (Bearded)	4	2	50.0	01801	00101	00802
Collie (Bearded)	4	1	25.0	New	00101	00201
Collie (Border)	22	4	18.2	00101	00101	00201
Collie (Border)	22	5	22.7	00201	00901	00101
Collie (Border)	22	1	4.5	00901	00101	00802
Collie (Border)	22	1	4.5	01201	00101	00201
Collie (Border)	22	6	27.3	01301	00101	00201
Collie (Border)	22	11	50.0	01501	00601	02301
Collie (Border)	22	1	4.5	01501	00901	00101
Collie (Border)	22	2	9.1	01502	00601	02301
Collie (Border)	22	1	4.5	01801	00101	00201
Collie (Border)	22	1	4.5	02001	00401	01303
Collie (Border)	22	5	22.7	02301	00301	00501
Collie (Border)	22	1	4.5	05401	00601	02301
Collie (Rough)	1	1	100.0	00201	00901	00101
Collie (Rough)	1	1	100.0	01501	00901	00101
Corgi	4	1	25.0	00201	00901	00101
Corgi	4	1	25.0	01501	00601	00301
Corgi	4	1	25.0	01501	00601	01101
Corgi	4	1	25.0	01501	00601	02002
Corgi	4	1	25.0	01501	00601	02301
Corgi	4	2	50.0	01801	00101	00201
Corgi	4	1	25.0	01801	00101	00802
Dachshund	3	2	66.7	00101	00101	00201
Dachshund	3	1	33.3	00901	00101	008011
Dachshund	3	1	33.3	07301	00201	01303
Dachshund (Long Haired)	3	2	66.7	00101	00101	00201
Dachshund (Long Haired)	3	1	33.3	01501	00601	02002
Dachshund (Long Haired)	3	1	33.3	01502	00601	02301
Dachshund (Long Haired)	3	1	33.3	04801	00101	00802
Dachshund (Miniature Short Haired)	11	6	54.5	00101	00101	00201
Dachshund (Miniature Short Haired)	11	5	45.5	00203	00901	00101
Dachshund (Miniature Short Haired)	11	1	9.1	00901	00101	008011
Dachshund (Miniature Short Haired)	11	1	9.1	01201	00101	00201
Dachshund (Miniature Short Haired)	11	1	9.1	01502	00601	02301
Dachshund (Miniature Short Haired)	11	1	9.1	04801	00101	00802
Dachshund (Miniature Short Haired)	11	4	36.4	07301	00201	01303
Dachshund (Miniature)	1	1	100.0	00101	00101	00201
Dachshund (Miniature)	1	1	100.0	00901	00101	008011
Dachshund (Short Haired)	5	1	20.0	00101	00101	00201



**Table 7** *Continued*

Breed	<i>n</i> = 1604	No. of dogs	Dogs of the breed (%)	DRB1	DQA1	DQB1
Dachshund (Short Haired)	5	1	20.0	00201	00901	00101
Dachshund (Short Haired)	5	1	20.0	00901	00101	008011
Dachshund (Short Haired)	5	2	40.0	01201	00401	01303/01701
Dachshund (Wire Haired)	1	1	100.0	00101	00101	00201
Dalmatian	4	1	25.0	00601	005011	00701
Dalmatian	4	2	50.0	01502	00601	02301
Dalmatian	4	2	50.0	02001	00401	01303
Dalmatian	4	1	25.0	New	00401	01303
Deerhound	1	1	100.0	01503	00601	02002
Deerhound	1	1	100.0	01601	00101	00802
Doberman	183	21	11.5	00201	00901	00101
Doberman	183	164	89.6	00601	00401	01303
Doberman	183	16	8.7	00601	005011	00701
Doberman	183	3	1.6	00601	005011	01303
Doberman	183	1	0.5	00901	00101	008011
Doberman	183	57	31.1	01201	00101	00201
Doberman	183	8	4.4	01501	00901	00101
German Langhaar	1	1	100.0	01201	00401	01303/01701
German Langhaar	1	1	100.0	01501	00601	02601
German Shepherd Dog Spain	13	1	7.7	00101	00101	00201
German Shepherd Dog Spain	13	1	7.7	00401	00201	01501
German Shepherd Dog Spain	13	7	53.8	01101	00201	01302
German Shepherd Dog Spain	13	8	61.5	01501	00601	00301
German Shepherd Dog Spain	13	3	23.1	01501	00601	02301
German Shepherd Dog Spain	13	1	7.7	01801	00101	00802
German Shepherd Dog Spain	13	1	7.7	04001	01001	01901
German Shepherd Dog Spain	13	1	7.7	New	00101	00201
German Shepherd Dog Spain	13	1	7.7	New	00301	00501
German Shepherd Dog UK	14	4	28.6	00101	00101	00201
German Shepherd Dog UK	14	3	21.4	00102	00101	00201
German Shepherd Dog UK	14	1	7.1	00201	00901	00101
German Shepherd Dog UK	14	1	7.1	00601	005011	00701
German Shepherd Dog UK	14	1	7.1	00901	00101	008011
German Shepherd Dog UK	14	6	42.9	01101	00201	01302
German Shepherd Dog UK	14	4	28.6	01501	00601	00301
German Shepherd Dog UK	14	1	7.1	01501	00601	02301
Great Dane	5	1	20.0	00101	00101	00201
Great Dane	5	1	20.0	00101	00301	00401
Great Dane	5	1	20.0	00601	005011	00701
Great Dane	5	2	40.0	00601	05011	00701
Great Dane	5	3	60.0	01201	00401	01303/01701
Great Dane	5	2	40.0	01601	00101	00201
Hovawart	4	2	50.0	00201	00901	00101
Hovawart	4	3	75.0	01301	00101	00201
Hovawart	4	1	25.0	01501	00601	02002
Hovawart	4	1	25.0	01501	00601	02301
Husky (Alaskan)	10	2	20.0	00201	00901	00101
Husky (Alaskan)	10	2	20.0	00601	005011	00701
Husky (Alaskan)	10	4	40.0	01201	00401	01303/01701
Husky (Alaskan)	10	4	40.0	01502	00601	02301
Husky (Alaskan)	10	3	30.0	04001	01001	01901
Husky (Alaskan)	10	1	10.0	04701	00402	New
Husky (Alaskan)	10	2	20.0	07001	01801	05001
Husky (Alaskan)	10	2	20.0	07801	00401	01303
Husky (Siberian)	1	1	100.0	00101	00101	00201

**Table 7** *Continued*

Breed	<i>n</i> = 1604	No. of dogs	Dogs of the breed (%)	DRB1	DQA1	DQB1
Husky (Siberian)	1	1	100.0	04001	01001	01901
Ibizan Hound	51	1	2.0	00101	00101	00201
Ibizan Hound	51	18	35.3	00601	005011	00701
Ibizan Hound	51	15	29.4	00802	00301	00401
Ibizan Hound	51	12	23.5	00901	00101	008011
Ibizan Hound	51	21	41.2	01503	00601	04801
Ibizan Hound	51	7	13.7	01801	00101	00802
Ibizan Hound	51	16	31.4	06901	00101	00201
Irish Wolfhound	1	1	100.0	00201	00901	00101
Irish Wolfhound	1	1	100.0	01501	00601	02002
Japanese Akita	1	1	100.0	00101	00101	00201
Japanese Akita	1	1	100.0	00201	00901	00101
Labrador (Retriever)	86	34	39.5	00101	00101	00201
Labrador (Retriever)	86	1	1.2	00101	00101	00802
Labrador (Retriever)	86	23	26.7	00601	005011	00701
Labrador (Retriever)	86	3	3.5	00601	005011	02001
Labrador (Retriever)	86	4	4.7	00802	00301	00401
Labrador (Retriever)	86	1	1.2	01101	00201	01302
Labrador (Retriever)	86	48	55.8	01201	00401	01303/01701
Labrador (Retriever)	86	2	2.3	01501	00601	00301
Labrador (Retriever)	86	16	18.6	01501	00601	02301
Labrador (Retriever)	86	1	1.2	01502	00601	00301
Labrador (Retriever)	86	24	27.9	01502	00601	02301
Labrador (Retriever)	86	2	2.3	02001	00401	01303
Labrador (Retriever)	86	1	1.2	New	01602	00802
Lagotto Romagnola	1	1	100.0	01501	00601	02001
Lagotto Romagnola	1	1	100.0	04801	00101	008011
Laika (West Siberian)	13	1	7.7	00101	00101	New
Laika (West Siberian)	13	1	7.7	010011	00201	01501
Laika (West Siberian)	13	3	23.1	01501	00601	01901/02201
Laika (West Siberian)	13	10	76.9	01501	00601	02301
Laika (West Siberian)	13	5	38.5	01501	00601	New
Laika (West Siberian)	13	3	23.1	02001	00401	01303
Laika (West Siberian)	13	1	7.7	04001	01001	01901
Leonburger	1	1	100.0	01601	00101	00201
Lhasa Apso	5	2	40.0	00601	005011	00701
Lhasa Apso	5	1	20.0	01501	00601	00301
Lhasa Apso	5	1	20.0	01501	00601	02301
Lhasa Apso	5	2	40.0	01502	00601	02301
Lhasa Apso	5	1	20.0	01502	00601	02601
Lhasa Apso	5	1	20.0	02001	00401	01303
Lurcher	4	1	25.0	00101	00101	00201
Lurcher	4	1	25.0	00201	00901	00101
Lurcher	4	1	25.0	00601	00401	01303
Lurcher	4	3	75.0	01801	00101	00802
Mongrel Brazilian	112	11	9.8	00101	00101	00201
Mongrel Brazilian	112	6	5.4	00101	00101	03601
Mongrel Brazilian	112	2	1.8	00101	00301	00401
Mongrel Brazilian	112	2	1.8	00102	00101	00201
Mongrel Brazilian	112	3	2.7	00201	00901	00101
Mongrel Brazilian	112	3	2.7	00601	00401	01303
Mongrel Brazilian	112	11	9.8	00601	005011	00701
Mongrel Brazilian	112	10	8.9	00901	00101	008011
Mongrel Brazilian	112	2	1.8	00901	00101	00802
Mongrel Brazilian	112	12	10.7	01101	00201	01303

**Table 7** *Continued*

Breed	<i>n</i> = 1604	No. of dogs	Dogs of the breed (%)	DRB1	DQA1	DQB1
Mongrel Brazilian	112	10	8.9	01301	00101	00201
Mongrel Brazilian	112	5	4.5	01301	00301	00501
Mongrel Brazilian	112	2	1.8	01501	00401	00301
Mongrel Brazilian	112	5	4.5	01501	00601	00301
Mongrel Brazilian	112	4	3.6	01501	00601	02001
Mongrel Brazilian	112	4	3.6	01501	00601	02002
Mongrel Brazilian	112	10	8.9	01501	00601	02301
Mongrel Brazilian	112	14	12.5	01501	00601	02601
Mongrel Brazilian	112	2	1.8	01501	01401	00301
Mongrel Brazilian	112	12	10.7	01502	00601	02301
Mongrel Brazilian	112	4	3.6	01702	00201	01304
Mongrel Brazilian	112	4	3.6	01801	00101	00802
Mongrel Brazilian	112	5	4.5	02001	00401	01303
Mongrel Brazilian	112	5	4.5	02301	00301	00501
Mongrel Brazilian	112	3	2.7	02501	012012	03501
Mongrel Brazilian	112	1	0.9	02901	00301	00401
Mongrel Brazilian	112	2	1.8	04601	01501	00802
Mongrel Brazilian	112	3	2.7	04801	00101	008011
Mongrel Brazilian	112	1	0.9	04801	00101	00802
Mongrel Brazilian	112	1	0.9	04901	005011	03901
Mongrel Brazilian	112	2	1.8	05001	00601	02302
Mongrel Brazilian	112	3	2.7	05101	00201	02901
Mongrel Brazilian	112	24	21.4	05201	012011	03501
Mongrel Brazilian	112	30	26.8	Other single haplotypes		
Newfoundland	75	20	26.7	00201	00901	00101
Newfoundland	75	14	18.7	00601	005011	00701
Newfoundland	75	32	42.7	00601	005011	02001
Newfoundland	75	35	46.7	01201	00401	01303/01701
Newfoundland	75	11	14.7	01301	00101	00201
Newfoundland	75	6	8.0	01501	00601	02301
Newfoundland	75	9	12.0	02001	00401	01303
Newfoundland	75	6	8.0	03001	00601	00301
Norwegian Elkhound	1	1	100.0	01501	00601	02301
Norwegian Elkhound	1	1	100.0	07601	00601	02301
Papillon	3	1	33.3	01501	00601	02301
Papillon	3	2	66.7	04601	01501	00802
Petit Basset Griffon Vendeen	1	1	100.0	00101	00101	00201
Petit Basset Griffon Vendeen	1	1	100.0	00601	005011	00701
Pharaoh Hound	1	1	100.0	08301	00201	01303
Pointer	1	1	100.0	00901	00101	008011
Pointer	1	1	100.0	04801	00101	008011
Pointer (German Short haired)	1	1	100.0	00101	00101	00201
Pointer (German Short haired)	1	1	100.0	00901	00101	008011
Polish Lowland Sheepdog	1	1	100.0	01301	00101	00201
Polish Lowland Sheepdog	1	1	100.0	01501	00901	00101
Pomeranian	2	1	50.0	00601	005011	00701
Pomeranian	2	2	100.0	01301	00101	00201
Pomeranian	2	1	50.0	New	00402	02301
Poodle	2	1	50.0	00301	00101	00802
Poodle	2	2	100.0	01501	00601	02601
Poodle (Miniature)	17	4	23.5	00101	00101	03601
Poodle (Miniature)	17	2	11.8	00601	005011	00701
Poodle (Miniature)	17	2	11.8	010011	00201	01501
Poodle (Miniature)	17	1	5.9	01301	00101	00201
Poodle (Miniature)	17	1	5.9	01501	00601	02002

**Table 7** *Continued*

Breed	<i>n</i> = 1604	No. of dogs	Dogs of the breed (%)	DRB1	DQA1	DQB1
Poodle (Miniature)	17	12	70.6	01501	00601	02301
Poodle (Miniature)	17	1	5.9	01501	00601	02601
Poodle (Miniature)	17	1	5.9	01502	00601	02301
Poodle (Miniature)	17	1	5.9	01503	00401	02301
Poodle (Miniature)	17	2	11.8	01503	00601	02301
Poodle (Miniature)	17	2	11.8	New	00101	00802
Poodle (Standard)	2	1	50.0	00601	005011	00701
Poodle (Standard)	2	2	100.0	01501	00601	02301
Poodle (Standard)	2	1	50.0	01503	00601	02301
Poodle (Toy)	5	1	20.0	00101	00101	03601
Poodle (Toy)	5	1	20.0	00201	00901	00101
Poodle (Toy)	5	1	20.0	00301	00101	00802
Poodle (Toy)	5	1	20.0	00501	00301	00501
Poodle (Toy)	5	3	60.0	01501	00601	02301
Poodle (Toy)	5	2	40.0	01502	00601	02601
Poodle (Toy)	5	1	20.0	02301	00301	00501
Poodle-Beagle-Elkhound X	93	36	38.7	00101	00101	00201
Poodle-Beagle-Elkhound X	93	12	12.9	00103	00101	00201
Poodle-Beagle-Elkhound X	93	1	1.1	00601	005011	00701
Poodle-Beagle-Elkhound X	93	14	15.1	010011	00201	01501
Poodle-Beagle-Elkhound X	93	13	14.0	01501	00601	02002
Poodle-Beagle-Elkhound X	93	51	54.8	01501	00601	02301
Poodle-Beagle-Elkhound X	93	39	44.1	07601	00601	02301
Poodle-Beagle-Elkhound X	93	1	1.1	New	00101	00201
Pudl (medium)	3	1	33.3	01501	00602	02002
Pudl (medium)	3	1	33.3	01503	00601	02301
Pudl (medium)	3	1	33.3	02601	00101	008011
Pudl (medium)	3	1	33.3	08401	00601	02301
Pudl (medium)	3	1	33.3	08401	00901	00101
Pudl (mini)	2	1	50.0	01501	00601	02301
Pudl (mini)	2	1	50.0	01502	00601	02601
Pudl (mini)	2	1	50.0	08401	00901	00101
Retriever (Chesapeake Bay)	1	1	100.0	00601	005011	00701
Retriever (Chesapeake Bay)	1	1	100.0	00901	00101	008011
Retriever (Flatcoat)	4	1	25.0	00401	00101	00201
Retriever (Flatcoat)	4	1	25.0	01201	00101	00201
Retriever (Flatcoat)	4	1	25.0	01201	01501	00201
Retriever (Flatcoat)	4	1	25.0	01301	00101	00201
Retriever (Flatcoat)	4	2	50.0	01501	00601	02301
Retriever (Golden)	31	2	6.5	00101	00101	00201
Retriever (Golden)	31	1	3.2	00601	005011	00701
Retriever (Golden)	31	5	16.1	00601	005011	02001
Retriever (Golden)	31	3	9.7	00901	00101	008011
Retriever (Golden)	31	14	45.2	01201	00401	01303
Retriever (Golden)	31	4	12.9	01201	00401	01303/01701
Retriever (Golden)	31	1	3.2	01501	00601	00301
Retriever (Golden)	31	10	32.3	01501	00601	02301
Retriever (Golden)	31	1	3.2	01502	00601	02301
Retriever (Golden)	31	1	3.2	01901	00401	01303
Retriever (Golden)	31	10	32.3	02001	00401	01303
Rhodesian Ridgeback	82	46	56.1	00101	00101	00201
Rhodesian Ridgeback	82	5	6.1	00101	00101	03601
Rhodesian Ridgeback	82	28	34.1	00601	00401	01303
Rhodesian Ridgeback	82	1	1.2	00601	005011	00701
Rhodesian Ridgeback	82	36	43.9	01301	00101	00201

**Table 7** *Continued*

Breed	<i>n</i> = 1604	No. of dogs	Dogs of the breed (%)	DRB1	DQA1	DQB1
Rhodesian Ridgeback	82	24	29.3	01801	00101	00802
Rhodesian Ridgeback	82	8	9.8	02001	00401	01303
Rottweiler	8	7	87.5	00101	00301	00401
Rottweiler	8	6	75.0	00601	005011	00701
Samoyed	15	1	6.7	00901	00101	008011
Samoyed	15	2	13.3	00901	00101	00802
Samoyed	15	4	26.7	00901	00101	04601
Samoyed	15	14	93.3	01501	00601	01901/02201
Samoyed	15	3	20.0	02001	00401	01303
Samoyed	15	1	6.7	04001	01001	01901
Schnauzer (Miniature)	13	1	7.7	00101	00101	00201
Schnauzer (Miniature)	13	3	23.1	00101	00101	03601
Schnauzer (Miniature)	13	1	7.7	00901	00101	00201
Schnauzer (Miniature)	13	10	76.9	00901	00101	008011
Schnauzer (Miniature)	13	3	23.1	01301	00101	00201
Schnauzer (Miniature)	13	1	7.7	01502	00101	008011
Schnauzer (Miniature)	13	1	7.7	01502	00601	00301
Schnauzer (Miniature)	13	1	7.7	01502	00601	02301
Setter (English)	41	34	82.9	00101	00101	00201
Setter (English)	41	1	2.4	00103	00101	00201
Setter (English)	41	11	26.8	00601	005011	00701
Setter (English)	41	2	4.9	00901	00101	008011
Setter (English)	41	4	9.8	01301	00101	00201
Setter (English)	41	1	2.4	01502	00601	02301
Setter (Gordon)	5	4	80.0	00101	00101	00201
Setter (Gordon)	5	1	20.0	00601	005011	00701
Setter (Gordon)	5	2	40.0	00901	00101	008011
Setter (Gordon)	5	1	20.0	01801	00101	00201
Setter (Irish)	3	3	100.0	00101	00101	00201
Setter (Irish)	3	2	66.7	00103	00101	00201
Setter (Irish)	3	1	33.3	02001	00401	01303
Sheepdog (Old English)	6	1	16.7	00401	00201	01501
Sheepdog (Old English)	6	1	16.7	00601	005011	00701
Sheepdog (Old English)	6	4	66.7	01301	00101	00201
Sheepdog (Old English)	6	1	16.7	01502	00601	02301
Sheepdog (Old English)	6	1	16.7	01801	00101	00802
Sheepdog (Shetland)	4	2	50.0	00201	00901	00101
Sheepdog (Shetland)	4	1	25.0	00202	00901	00101
Sheepdog (Shetland)	4	2	50.0	01501	00901	00101
Shepherd Dog (Caucasian)	6	1	16.7	00102	00101	008011
Shepherd Dog (Caucasian)	6	1	16.7	00901	00101	008011
Shepherd Dog (Caucasian)	6	1	16.7	01301	00601	02601
Shepherd Dog (Caucasian)	6	2	33.3	01501	00201	01303
Shepherd Dog (Caucasian)	6	1	16.7	01501	00601	04901
Shepherd Dog (Caucasian)	6	1	16.7	02001	00401	01303
Shepherd Dog (Caucasian)	6	1	16.7	03202	00101	008011
Shepherd Dog (Caucasian)	6	1	16.7	New	00101	008011
Shepherd Dog (Caucasian)	6	1	16.7	New	00601	02002
Shepherd Dog (Caucasian)	6	1	16.7	New	00601	02101
Shepherd Dog (Middle Asian)	42	1	2.4	00101	00101	00201
Shepherd Dog (Middle Asian)	42	1	2.4	00101	00301	00401
Shepherd Dog (Middle Asian)	42	3	7.1	00201	00901	00101
Shepherd Dog (Middle Asian)	42	4	9.5	00601	005011	00701
Shepherd Dog (Middle Asian)	42	4	9.5	00901	00101	008011
Shepherd Dog (Middle Asian)	42	1	2.4	010011	01001	01901

**Table 7** *Continued*

Breed	<i>n</i> = 1604	No. of dogs	Dogs of the breed (%)	DRB1	DQA1	DQB1
Shepherd Dog (Middle Asian)	42	3	7.1	01501	00601	00301
Shepherd Dog (Middle Asian)	42	5	11.9	01501	00601	02301
Shepherd Dog (Middle Asian)	42	4	9.5	01501	00601	04901
Shepherd Dog (Middle Asian)	42	5	11.9	01501	00601	New
Shepherd Dog (Middle Asian)	42	1	2.4	01502	00601	01302
Shepherd Dog (Middle Asian)	42	4	9.5	01502	00601	02301
Shepherd Dog (Middle Asian)	42	2	4.8	02001	00401	01302
Shepherd Dog (Middle Asian)	42	7	16.7	02001	00401	01303
Shepherd Dog (Middle Asian)	42	1	2.4	02501	012012	03501
Shepherd Dog (Middle Asian)	42	1	2.4	03202	00401	01302
Shepherd Dog (Middle Asian)	42	6	14.3	04801	00402	03101
Shepherd Dog (Middle Asian)	42	1	2.4	04801	00402	New
Shepherd Dog (Middle Asian)	42	1	2.4	05301	00301	00501
Shepherd Dog (Middle Asian)	42	1	2.4	05301	00301	00502
Shepherd Dog (Middle Asian)	42	1	2.4	07401	00101	New
Shepherd Dog (Middle Asian)	42	1	2.4	07401	005011	00701
Shepherd Dog (Middle Asian)	42	8	19.0	08001	00402	None
Shepherd Dog (Middle Asian)	42	16	38.1	Other single haplotypes		
Shih Tzu	13	6	46.2	00601	005011	00701
Shih Tzu	13	1	7.7	01501	00601	02301
Shih Tzu	13	3	23.1	01502	00601	02301
Shih Tzu	13	3	23.1	02001	00401	01303
Shih Tzu	13	7	53.8	02501	012012	03501
Shih Tzu	13	4	30.8	03301	00301	03801
Shih Tzu	13	1	7.7	05301	00301	00501
Spaniel (Cavalier King Charles)	14	1	7.1	00601	005011	02001
Spaniel (Cavalier King Charles)	14	5	35.7	00901	00101	008011
Spaniel (Cavalier King Charles)	14	9	64.3	01101	00201	01303
Spaniel (Cavalier King Charles)	14	8	57.1	02001	00401	01303
Spaniel (Cocker)	30	1	3.3	00101	00101	00201
Spaniel (Cocker)	30	2	6.7	00102	00101	00201
Spaniel (Cocker)	30	21	70.0	00601	005011	00701
Spaniel (Cocker)	30	2	6.7	00601	005011	02001
Spaniel (Cocker)	30	2	6.7	00901	00101	008011
Spaniel (Cocker)	30	1	3.3	01101	00201	01303
Spaniel (Cocker)	30	1	3.3	01201	00401	01303/01701
Spaniel (Cocker)	30	1	3.3	01501	00601	00301
Spaniel (Cocker)	30	2	6.7	01501	00601	02002
Spaniel (Cocker)	30	1	3.3	01503	00901	00101
Spaniel (Springer)	12	2	16.7	00101	00201	01303
Spaniel (Springer)	12	1	8.3	00501	00301	00501
Spaniel (Springer)	12	2	16.7	00601	005011	00701
Spaniel (Springer)	12	1	8.3	00802	00301	00401
Spaniel (Springer)	12	1	8.3	01201	00401	01303/01701
Spaniel (Springer)	12	2	16.7	01501	00601	00301
Spaniel (Springer)	12	3	25.0	01501	00601	02002
Spaniel (Springer)	12	2	16.7	01501	00601	02301
Spaniel (Springer)	12	2	16.7	02001	00401	01303
Spitz (German)	1	1	100.0	00901	00101	008011
St Bernard	1	1	100.0	00901	00101	008011
St Bernard	1	1	100.0	02001	00401	01303
Tanzanian mongrel	27	4	14.8	00101	00101	00201
Tanzanian mongrel	27	2	7.4	00101	00101	03601
Tanzanian mongrel	27	2	7.4	00102	00101	00201
Tanzanian mongrel	27	1	3.7	00201	00901	00101

**Table 7** *Continued*

Breed	<i>n</i> = 1604	No. of dogs	Dogs of the breed (%)	DRB1	DQA1	DQB1
Tanzanian mongrel	27	2	7.4	00501	00301	00501
Tanzanian mongrel	27	2	7.4	00601	005011	00701
Tanzanian mongrel	27	8	29.6	00901	00101	008011
Tanzanian mongrel	27	2	7.4	01501	00601	00301
Tanzanian mongrel	27	3	11.1	01501	00601	02002
Tanzanian mongrel	27	3	11.1	01501	00601	02301
Tanzanian mongrel	27	4	14.8	08101	00101	00802
Tanzanian mongrel	27	3	11.1	New	00402	02301
Tanzanian mongrel	27	17	63.0	Other single haplotypes		
Terrier (Airedale)	2	2	100.0	00601	005011	02801
Terrier (Border)	10	4	40.0	00201	00901	00101
Terrier (Border)	10	1	10.0	00201	00901	00802
Terrier (Border)	10	1	10.0	00201	00901	03001
Terrier (Border)	10	1	10.0	00202	00901	00101
Terrier (Border)	10	2	20.0	00501	00901	02301
Terrier (Border)	10	1	10.0	00802	00301	00502
Terrier (Border)	10	1	10.0	01101	00201	01302
Terrier (Border)	10	6	60.0	01501	00601	02002
Terrier (Border)	10	1	10.0	02001	00401	01303
Terrier (Bull)	1	1	100.0	00601	00401	01303
Terrier (Bull)	1	1	100.0	01301	00101	00201
Terrier (Cairn)	12	2	16.7	00101	00101	00201
Terrier (Cairn)	12	1	8.3	00201	00901	00101
Terrier (Cairn)	12	3	25.0	00901	00101	008011
Terrier (Cairn)	12	1	8.3	01501	00601	00301
Terrier (Cairn)	12	1	8.3	01501	00601	01101
Terrier (Cairn)	12	6	50.0	01501	00601	02301
Terrier (Cairn)	12	7	58.3	01502	00601	02301
Terrier (Fox)	1	1	100.0	01301	00101	00201
Terrier (Jack Russell)	39	10	25.6	00101	00101	00201
Terrier (Jack Russell)	39	1	2.6	00101	00101	00501
Terrier (Jack Russell)	39	6	15.4	00101	00101	03601
Terrier (Jack Russell)	39	1	2.6	00101	00201	01303
Terrier (Jack Russell)	39	1	2.6	00101	00301	00501
Terrier (Jack Russell)	39	1	2.6	00102	00101	00201
Terrier (Jack Russell)	39	5	12.8	00201	00901	00101
Terrier (Jack Russell)	39	1	2.6	00501	00301	00501
Terrier (Jack Russell)	39	4	10.3	00601	005011	00701
Terrier (Jack Russell)	39	1	2.6	00901	00101	00201
Terrier (Jack Russell)	39	6	15.4	00901	00101	008011
Terrier (Jack Russell)	39	2	5.1	00901	00101	00802
Terrier (Jack Russell)	39	2	5.1	01101	00201	01302
Terrier (Jack Russell)	39	2	5.1	01201	00401	01303/01701
Terrier (Jack Russell)	39	6	15.4	01301	00101	00201
Terrier (Jack Russell)	39	2	5.2	01501	00601	00301
Terrier (Jack Russell)	39	3	7.7	01501	00601	02201
Terrier (Jack Russell)	39	6	15.4	01501	00601	02301
Terrier (Jack Russell)	39	1	2.6	01502	00601	02301
Terrier (Jack Russell)	39	1	2.6	01701	00201	01303
Terrier (Jack Russell)	39	1	2.6	01801	00101	00201
Terrier (Jack Russell)	39	4	10.3	01801	00101	00802
Terrier (Jack Russell)	39	1	2.6	02001	00401	01303
Terrier (Jack Russell)	39	3	7.7	Other single haplotypes		
Terrier (Lakeland)	1	1	100.0	00901	01501	00101
Terrier (Lakeland)	1	1	100.0	07601	00601	02201

**Table 7** *Continued*

Breed	<i>n</i> = 1604	No. of dogs	Dogs of the breed (%)	DRB1	DQA1	DQB1
Terrier (Maltese)	1	1	100.0	01501	02101	05301
Terrier (Maltese)	1	1	100.0	07401	005011	00701
Terrier (Norwich)	1	1	100.0	01502	00601	02301
Terrier (Scottish)	2	1	50.0	00101	00101	00201
Terrier (Scottish)	2	2	100.0	00901	00101	008011
Terrier (Scottish)	2	1	50.0	01501	00101	00201
Terrier (Soft Coated Wheaten)	1	1	100.0	00601	005011	00701
Terrier (Soft Coated Wheaten)	1	1	100.0	01501	00601	02301
Terrier (Staffs Bull)	19	12	63.2	00101	00101	00201
Terrier (Staffs Bull)	19	1	5.3	00201	00901	00101
Terrier (Staffs Bull)	19	1	5.3	00601	005011	00701
Terrier (Staffs Bull)	19	9	47.4	01301	00101	00201
Terrier (Staffs Bull)	19	1	5.3	01501	00601	02301
Terrier (Staffs Bull)	19	3	15.8	01501	00901	00101
Terrier (Tibetan)	6	1	16.7	00101	00101	00201
Terrier (Tibetan)	6	1	16.7	00101	00601	02301
Terrier (Tibetan)	6	1	16.7	00601	005011	00701
Terrier (Tibetan)	6	1	16.7	00901	00101	008011
Terrier (Tibetan)	6	1	16.7	01501	00601	02301
Terrier (Tibetan)	6	1	16.7	01502	00601	02301
Terrier (Tibetan)	6	4	66.7	07901	00101	00201
Terrier (West Highland White)	22	12	54.5	00101	00101	00201
Terrier (West Highland White)	22	11	50.0	00101	00901	00101
Terrier (West Highland White)	22	2	9.1	01501	00601	00301
Terrier (West Highland White)	22	4	18.2	01501	00601	01101
Terrier (West Highland White)	22	7	31.8	01501	00601	02002
Terrier (West Highland White)	22	2	9.1	01501	00901	00101
Terrier (West Highland White)	22	1	4.5	01501	014011	02601
Terrier (West Highland White)	22	1	4.5	01502	00601	02301
Terrier (West Highland White)	22	1	4.5	01801	00101	00201
Terrier (Yorkshire)	44	2	4.5	00101	00101	03601
Terrier (Yorkshire)	44	5	11.4	00201	00901	00101
Terrier (Yorkshire)	44	3	6.8	00202	00901	00101
Terrier (Yorkshire)	44	1	2.3	00501	00301	00501
Terrier (Yorkshire)	44	27	61.4	00601	005011	00701
Terrier (Yorkshire)	44	4	9.1	00601	005011	02801
Terrier (Yorkshire)	44	1	2.3	00801	00301	00401
Terrier (Yorkshire)	44	1	2.3	01101	00201	01302
Terrier (Yorkshire)	44	2	4.5	01301	00101	00201
Terrier (Yorkshire)	44	1	2.3	01501	00601	02002
Terrier (Yorkshire)	44	6	13.6	01501	00601	02201
Terrier (Yorkshire)	44	3	6.8	01501	00601	02301
Terrier (Yorkshire)	44	1	2.3	01502	00601	00301
Terrier (Yorkshire)	44	1	2.3	01502	00601	02201
Terrier (Yorkshire)	44	8	18.2	01502	00601	02301
Terrier (Yorkshire)	44	1	2.3	01701	00201	01303
Terrier (Yorkshire)	44	3	6.8	02301	00301	00501
Terrier (Yorkshire)	44	1	2.3	05201	012011	03501
Terrier (Yorkshire)	44	2	4.5	07501	00401	01303
Vizsla Hungarian	2	2	100.0	02001	00401	01303
Volfdog (Caucasian)	12	3	25.0	00601	005011	00701
Volfdog (Caucasian)	12	2	16.7	01101	00201	01302
Volfdog (Caucasian)	12	1	8.3	01101	00201	01303
Volfdog (Caucasian)	12	1	8.3	01501	00901	00101
Volfdog (Caucasian)	12	1	8.3	01502	00601	00301



**Table 7** *Continued*

Breed	<i>n</i> = 1604	No. of dogs	Dogs of the breed (%)	DRB1	DQA1	DQB1
Volfdog (Caucasian)	12	5	41.7	01502	00601	02301
Volfdog (Caucasian)	12	3	25.0	02001	00401	01303
Volfdog (Caucasian)	12	1	8.3	04801	00402	03101
Volfdog (Caucasian)	12	2	16.6	New	005011	00701
Volfdog (Caucasian)	12	1	8.3	New	00601	02002
Volfdog (Caucasian)	12	2	16.6	New	00601	02301
Weimaraner	2	1	50.0	00101	00101	00201
Weimaraner	3	2	66.7	01201	00401	01303/01701
Weimaraner	3	3	100.0	01501	00601	02002
X-Crossbreed	85	15	17.6	00101	00101	00201
X-Crossbreed	85	1	1.2	00101	00101	03601
X-Crossbreed	85	1	1.2	00101	00301	00501
X-Crossbreed	85	3	3.5	00101	00901	00101
X-Crossbreed	85	1	1.2	00103	00101	00201
X-Crossbreed	85	14	16.5	00201	00901	00101
X-Crossbreed	85	1	1.2	00401	00201	01501
X-Crossbreed	85	1	1.2	00601	00401	01303
X-Crossbreed	85	5	5.9	00601	005011	00701
X-Crossbreed	85	1	1.2	00601	005011	02801
X-Crossbreed	85	1	1.2	00801	00301	00401
X-Crossbreed	85	1	1.2	00802	00301	00401
X-Crossbreed	85	1	1.2	00901	00101	00201
X-Crossbreed	85	8	9.4	00901	00101	008011
X-Crossbreed	85	7	8.2	01101	00201	01302
X-Crossbreed	85	7	8.2	01201	00401	01303/01701
X-Crossbreed	85	9	10.6	01301	00101	00201
X-Crossbreed	85	1	1.2	01501	00401	01303
X-Crossbreed	85	9	10.6	01501	00601	00301
X-Crossbreed	85	4	4.7	01501	00601	02201
X-Crossbreed	85	7	8.2	01501	00601	02301
X-Crossbreed	85	3	3.5	01501	00901	00101
X-Crossbreed	85	2	2.4	01501	02101	05301
X-Crossbreed	85	13	15.3	01502	00601	02301
X-Crossbreed	85	1	1.2	01502	00901	00101
X-Crossbreed	85	1	1.2	01801	00101	00201
X-Crossbreed	85	4	4.7	01801	00101	00802
X-Crossbreed	85	9	10.6	02001	00401	01303
X-Crossbreed	85	5	5.9	02301	00301	00501
X-Crossbreed	85	2	2.4	07601	00601	02301
X-Crossbreed	85	3	3.5	Other single haplotypes		

**Conflict of Interest Statement**

All authors have declared no conflicts of interests.

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